UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2012/2013

COURSE NAME	:	QUALITY CONTROL
COURSE CODE	:	BPB 24303
PROGRAMME	:	2 BPB
EXAMINATION DATE	:	JUNE 2013
DURATION	:	3 HOURS
INSTRUCTIONS	:	SECTION A ANSWER **ALL** QUESTIONS SECTION B ANSWER **FOUR (4)** OUT OF FIVE QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SIXTEEN (16)** PAGES

SECTION A (20 MARKS)

Q1 (a) A new quality improverment process is started in Kiyoh Industries, and the sum of the sample standard deviations for 25 subgroups of size 4 is 750 with the specifications of 700 ± 80.

(i) Determine the process capability (C_p).

(2 marks)

(ii) Calculate the C_{pk} value for the information given in Q1(a) when the prosess average is 700, 740, 780 and 820.

(2 marks)

(b) The net weight of a soft drink is to be monitored by $\bar{x}$ and R control charts using a sample size of $n = 5$. Data for 20 preliminary samples are shown in **Table Q1(b)**.

Table Q1(b): Soft drink weight

Sample Number	x_1	x_2	x_3	x_4	x_5
1	15.8	16.3	16.2	16.1	16.6
2	16.3	15.9	15.9	16.2	16.4
3	16.1	16.2	16.5	16.4	16.3
4	16.3	16.2	15.9	16.4	16.2
5	16.1	16.1	16.4	16.5	16
6	16.1	15.8	16.7	16.6	16.4
7	16.1	16.3	16.5	16.1	16.5
8	16.2	16.1	16.2	16.1	16.3
9	16.3	16.2	16.4	16.3	16.5
10	16.6	16.3	16.4	16.1	16.5
11	16.2	16.4	15.9	16.3	16.4
12	15.9	16.6	16.7	16.2	16.5
13	16.4	16.1	16.6	16.4	16.1
14	16.5	16.3	16.2	16.3	16.4
15	16.4	16.1	16.3	16.2	16.2
16	16	16.2	16.3	16.3	16.2
17	16.4	16.2	16.4	16.3	16.2
18	16	16.2	16.4	16.5	16.1
19	16.4	16	16.3	16.4	16.4
20	16.4	16.4	16.5	16	15.8

(i) Calculate the grand mean.

(2 marks)

(ii) Calculate the average range.

(2 marks)

(iii) Estimate the standard deviation. Refer to **Appendix I** for subgroup size.

(3 marks)

(iv) Assume that your business is operating at the three-sigma quality level.

Determine the upper limit (UCL), central limit (CL) and lower Limit (LCL) for $\bar{\bar{X}}$ and R control charts.

(3 marks)

(v) Plot on the graph paper the $\bar{\bar{X}}$ and R control chart based from the **Q1(b)(iii)** calculation.

(6 marks)

SECTION B (80 MARKS)

Q2 (a) Besides $\bar{X}$ and R charts, there are several control charts for variables that can be used in quality inspection.

(i) State **TWO (2)** additional control charts for variables.

(2 marks)

(ii) Differentiate between continuous processes and batch processes.

(5 marks)

(b) Explain the use of multi-vari chart in improving products and services quality.

(7 marks)

(c) **Table Q2(c)** presents the shampoo weights in kilograms.

Table Q2(c): Shampoo weight (kg)

Subgroup	x_1	x_2	x_3
1	24.97	25.01	25.00
2	25.08	25.06	25.09
3	25.03	25.04	24.98

(i) Determine the central lines and control limits for $\bar{Z}$ and MW charts with a subgroup size of 3.

(2 marks)

(ii) Calculate the plotted points for the following three subgroup, if the target $\bar{\bar{X}}$ is 25.00 and target $\bar{R}$ is 0.05.

(2 marks)

(iii) Identify if any points is out of control.

(2 marks)

Q3 (a) Company X is an electronic circuit board manufacturer in Malaysia. Quality control unit has been assigned to take samples of the circuit assemblies to monitor the case of nonconforming. The data in **Table Q3(a)** shows the number of nonconforming circuit board assemblies in samples of size 100.

Table Q3(a) : Nonconforming circuit board

Sample Number	Number of Nonconforming Assemblies	Sample Number	Number of Nonconforming Assemblies
1	7	11	6
2	4	12	15
3	1	13	0
4	3	14	9
5	6	15	5
6	8	16	1
7	10	17	4
8	5	18	5
9	2	19	7
10	7	20	12

(i) Plot a fraction nonconforming control chart.

(8 marks)

(ii) Assume the assignable causes can be found.

Illustrate the revised control limits, if any points plot out of control.

(8 marks)

(b) The manufacturer wishes to set up a control chart at the final inspection station for a gas water heater. Defects in workmanship and visual quality features are checked in this inspection. For the past 22 working days, 176 water heaters were inspected and a total of 924 nonconformaties reported.

(i) Suggest **ONE (1)** control chart that is suitable based from the given information for the company.

(2 marks)

(ii) Calculate the control limits and central line that are consistent with the past 22 days of inspection data.

(2 marks)

Q4 (a) (i) State **TWO (2)** important aspect of sampling.

(4 marks)

(iii) It is desired to have a single sampling plan where the risk of rejecting a 1.0% nonconforming lot is 0.05.

Determine the sample size for an acceptance number of 3.

(2 marks)

(b) **Table Q4(b)** shows the operating characteristics (OC) curve values. Determine the average outgoing quality (AOQ) curve for N = 2000, n = 50, c = O and p, the quality of incoming lots is 0.03.

(2 marks)

Table Q4(b): Operating characteristics (OC) curve values

P	Pα
Fraction non-conforming	Probability of acceptance of the lot
0.01	0.9984
0.02	0.9822
0.03	0.9372
0.04	0.8609
0.05	0.7604
0.06	0.6473
0.07	0.5327
0.08	0.4253
0.09	0.3303
0.1	0.2503
0.15	0.046
0.2	0.0057

(c) Dixar company ships a component in lots with the size, N = 3000. The acceptable quality level (AQL) has been established for this product at 1%.

(i) Assume the general inspection level II is appropriate.

Calculate the normal, tightened, and reduced single-sampling plans for this situation from MIL STD 105E master table in **Appendix III, IV and V** standard by using the sample size code table in **Appendix II**.

(3 marks)

(ii) Calculate the normal, tightened, and reduced single-sampling plans using general inspection level I and MIL STD 105E master table in **Appendix III, IV and V**. Refer to sample size code table in **Appendix II**.

(3 marks)

(iii) Explain the switching rule procedures between normal, tightened, and reduced inspection, based on MIL STD 105E with an appropriate diagram.

(6 marks)

Q5 (a) Identify **FOUR (4)** objectives of the experimental design.

(4 marks)

(b) Draw a general model of experimental design based on answer in **Q5(a)**.

(4 marks)

(c) Discuss the recommended procedure or processes involve for designing an experiment as outlined by Montgomery (2009).

(12 marks)

Q6 (a) An electronic component in a dental x-ray system has an exponential time to failure distribution with $\lambda = 0.00004$.

(i) Calculate the mean of the time to failure.

(1 mark)

(ii) Calculate the variance of the time to failure.

(1 mark)

(iii) Calculate the reliability at 30,000 hours.

(2 marks)

(b) A synthetic fibre is stressed by repeatedly applying a particular load. Suppose that the number of cycles to failure has an exponential distribution with mean 3,000 cycles.

(i) Determine the probability that the fibre will break at 1,500 cycles.

(2 marks)

(ii) Determine the probability that the fibre will break at 2,500 cycles.

(2 marks)

(c) Suppose that $n = 20$ units are placed on test and that five of them fail at 20, 25, 40, 75, and 100 hours, respectively. The test is terminated at 100 hours without replacing any of the failed units. **Table Q6(c)** shows the failure time and numbers of failed units.

Table Q6(c): Failure time and numbers of failed units

Failure time	Failed units
20	1
25	1
40	1
75	1
100	1
≥ 100	15

(i) Calculate the failure rate.

(4 marks)

(d) The outputs from a FMEA may include documentation for each system, subsystem, process, or service and recommendations for design changes or corrective actions.

(i) State **TWO (2)** basic steps in a failure mode and effects analysis (FMEA).

(2 marks)

(ii) The risk priority numbers (RPN) have three components, known as severity, occurrence and detection. Calculate the values of the RPNs from the information given in **Table Q6(d)**.

(4 marks)

Table Q6(d): FMEA

Potential Failure	Severity	Occurrence	Detection
1	4	2	1
2	5	5	4
3	9	3	4
4	4	4	6
5	10	9	6
6	2	3	4
7	1	4	4
8	7	5	2
9	8	2	3
10	5	5	6

(iii) Re-arrange the values of the RPN in **Table Q6(d)** accordingly based on priority in developing corrective actions for potential failures.

(2 marks)

Appendix I

FINAL EXAMINATION

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TABLE B Factors for Computing Central Lines and 3σ Control Limits for $\bar{X}$, s, and R Charts

OBSERVATIONS IN SAMPLE, n	CHART FOR AVERAGES: FACTORS FOR CONTROL LIMITS A	A_2	A_3	CHART FOR STANDARD DEVIATIONS: FACTOR FOR CENTRAL LINE c_4	FACTORS FOR CONTROL LIMITS B_3	B_4	B_5	B_6	CHART FOR RANGES: FACTOR FOR CENTRAL LINE d_2	FACTORS FOR CONTROL LIMITS d_3	D_1	D_2	D_3	D_4
2	2.121	1.880	2.659	0.7979	0	3.267	0	2.606	1.128	0.853	0	3.686	0	3.267
3	1.732	1.023	1.954	0.8862	0	2.568	0	2.276	1.693	0.888	0	4.358	0	2.574
4	1.500	0.729	1.628	0.9213	0	2.266	0	2.088	2.059	0.880	0	4.698	0	2.282
5	1.342	0.577	1.427	0.9400	0	2.089	0	1.964	2.326	0.864	0	4.918	0	2.114
6	1.225	0.483	1.287	0.9515	0.030	1.970	0.029	1.874	2.534	0.848	0	5.078	0	2.004
7	1.134	0.419	1.182	0.9594	0.118	1.882	0.113	1.806	2.704	0.833	0.204	5.204	0.076	1.924
8	1.061	0.373	1.099	0.9650	0.185	1.815	0.179	1.751	2.847	0.820	0.388	5.306	0.136	1.864
9	1.000	0.337	1.032	0.9693	0.239	1.761	0.232	1.707	2.970	0.808	0.547	5.393	0.184	1.816
10	0.949	0.308	0.975	0.9727	0.284	1.716	0.276	1.669	3.078	0.797	0.687	5.469	0.223	1.777
11	0.905	0.285	0.927	0.9754	0.321	1.679	0.313	1.637	3.173	0.787	0.811	5.535	0.256	1.744
12	0.866	0.266	0.886	0.9776	0.354	1.646	0.346	1.610	3.258	0.778	0.922	5.594	0.283	1.717
13	0.832	0.249	0.850	0.9794	0.382	1.618	0.374	1.585	3.336	0.770	1.025	5.647	0.307	1.693
14	0.802	0.235	0.817	0.9810	0.406	1.594	0.399	1.563	3.407	0.763	1.118	5.696	0.328	1.672
15	0.775	0.223	0.789	0.9823	0.428	1.572	0.421	1.544	3.472	0.756	1.203	5.741	0.347	1.653
16	0.750	0.212	0.763	0.9835	0.448	1.552	0.440	1.526	3.532	0.750	1.282	5.782	0.363	1.637
17	0.728	0.203	0.739	0.9845	0.466	1.534	0.458	1.511	3.588	0.744	1.356	5.820	0.378	1.622
18	0.707	0.194	0.718	0.9854	0.482	1.518	0.475	1.496	3.640	0.739	1.424	5.856	0.391	1.608
19	0.688	0.187	0.698	0.9862	0.497	1.503	0.490	1.483	3.689	0.734	1.487	5.891	0.403	1.597
20	0.671	0.180	0.680	0.9869	0.510	1.490	0.504	1.470	3.735	0.729	1.549	5.921	0.415	1.585

Appendix II

FINAL EXAMINATION

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COURSE CODE : BPB 24303

Sample Size Code Letters (MIL STD 105E, Table 1)

	Special Inspection Levels				General Inspection Levels		
Lot or Batch Size	**S-1**	**S-2**	**S-3**	**S-4**	**I**	**II**	**III**
2 to 8	A	A	A	A	A	A	B
9 to 15	**A**	**A**	**A**	**A**	**A**	**B**	**C**
16 to 25	A	A	B	B	B	C	D
26 to 50	**A**	**B**	**B**	**C**	**C**	**D**	**E**
51 to 90	B	B	C	C	C	E	F
91 to 150	**B**	**B**	**C**	**D**	**D**	**F**	**G**
151 to 280	B	C	D	E	E	G	H
281 to 500	**B**	**C**	**D**	**E**	**F**	**H**	**J**
501 to 1200	C	C	E	F	G	J	K
1201 to 3200	**C**	**D**	**E**	**G**	**H**	**K**	**L**
3201 to 10,000	C	D	F	G	J	L	M
10,001 to 35,000	**C**	**D**	**F**	**H**	**K**	**M**	**N**
35,001 to 150,000	D	E	G	J	L	N	P
150,001 to 500,000	**D**	**E**	**G**	**J**	**M**	**P**	**Q**
500,001 and over	D	E	H	K	N	Q	R

Appendix III

FINAL EXAMINATION

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PROGRAMME : 2 BPB
COURSE CODE : BPB 24303

Master Table for Normal Inspection for Single-Sampling (U.S. Department of Defense MIL STD 105E, Table II-A)

Sample Size Code Letter	Sample Size	Acceptable Quality Levels (normal inspection)																																					
		0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10		15		25		40		65		100		150		250		400		650		1000	
		Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
A	2	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇧		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31
B	3																											0	1	⇧		⇧		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31	44	45
C	5																							⇩		⇩		⇧		⇧		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31	44	45		
D	8																							0	1	⇧		⇧		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31	44	45	⇧	
E	13																					0	1	⇧		⇧		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31	44	45				
F	20																							⇧		⇧		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22								
G	32																	0	1	⇧		⇧		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧									
H	50															0	1	⇧		⇧		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧											
J	80													0	1	⇧		⇧		⇧		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22												
K	125											0	1	⇧		⇧		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧															
L	200													⇧		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22																		
M	315													⇧		2	3	3	4	5	6	7	8	10	11	14	15	21	22																				
N	500																																															
P	800																																														
Q	1250																																														
R	2000																																														

⇩ = Use first-sampling plan below arrow, if sample size equals, or exceeds, lot or batch size, do 100% inspection.

⇧ = Use first-sampling plan above arrow.

Ac = Acceptance number.

Re = Rejection number.

Appendix IV

FINAL EXAMINATION

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PROGRAMME : 2 BPB
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Master Table for Tightened Inspection—Single-Sampling (U.S. Department of Defense MIL STD 105E, Table II-B)

Sample Size Code Letter	Sample Size	Acceptable Quality Levels (tightened inspection)																																					
		0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10		15		25		40		65		100	
		Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
A	2	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇩		⇩		1	2	2	3	3	4
B	3																																	1	2	2	3	3	4	5	6
C	5																									0	1					1	2	2	3	3	4	5	6	8	9
D	8																							0	1			1	2	2	3	3	4	5	6	8	9	12	13
E	13																					0	1			1	2	2	3	3	4	5	6	8	9	12	13	18	19
F	20																							1	2	2	3	3	4	5	6	8	9	12	13	18	19		
G	32																			0	1			2	3	3	4	5	6	8	9	12	13	18	19				
H	50																	0	1			1	2	3	4	5	6	8	9	12	13	18	19						
J	80															0	1			1	2	2	3	4	5	6	8	9	12	13	18	19								
K	125													0	1			1	2	2	3	3	4	5	6	8	9	12	13	18	19								
L	200											0	1			1	2	2	3	3	4	5	6	8	9	12	13	18	19										
M	315									0	1			1	2	2	3	3	4	5	6	8	9	12	13	18	19												
N	500							0	1			1	2	2	3	3	4	5	6	8	9	12	13	18	19														
P	800					0	1			1	2	2	3	3	4	5	6	8	9	12	13	18	19																
Q	1250			0	1			1	2	2	3	3	4	5	6	8	9	12	13	18	19																		
R	2000	0	1	⇧		⇩		1	2	2	3	3	4	5	6	8	9	12	13	18	19	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
S	3150					1	2																																

Sample Size Code Letter	Sample Size	110		150		250		400		650		1000	
		Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
A	2												
B	3												
C	5												
D	8												
E	13												
F	20												
G	32												
H	50												
J	80												
K	125												
L	200												
M	315												
N	500												
P	800												
Q	1250												
R	2000	⇧		⇧		⇧		⇧		⇧		⇧	
S	3150												

⇩ = Use first-sampling plan below arrow. If sample size equals, or exceeds, lot or batch size, do 100% inspection.

⇧ = Use first-sampling plan above arrow.

Ac = Acceptance number.

Re = Rejection number.

Appendix V

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Master Table for Reduced Inspection—Single-Sampling (U.S. Department of Defense MIL STD 105E, Table II-C)

Sample Size Code Letter	Sample Size	Acceptable Quality Levels (reduced inspection)†																																					
		0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10		15		25		40		65		100		150		250		400		650		1000	
		Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
A	2	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇩		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31
B	2																											0	1	⇧		⇩		0	2	1	3	2	4	3	5	5	6	7	8	10	11	14	15	21	22	30	31
C	2																											⇧		⇧		0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13	14	17	21	24				
D	3																							⇩		⇩		⇩		0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13	14	17	21	24				
E	5																					⇩		⇧		⇧		⇧		1	3	1	4	2	5	3	6	5	8	7	10	10	13										
F	8																			⇩		⇧		⇧		⇧		⇧		1	4	2	5	3	6	5	8	7	10	10	13										
G	13																	⇩		⇧		⇧		⇧		⇧		⇧		2	5	3	6	5	8	7	10	10	13										
H	20															⇩		⇧		⇧		⇧		⇧		⇧		⇧		3	6	5	8	7	10	10	13										
J	32													⇩		⇧		⇧		⇧		⇧		⇧		⇧		⇧		5	8	7	10	10	13										
K	50											⇩		⇧		⇩		⇧		⇧		⇧		⇧		⇧		⇧		7	10	10	13										
L	80															⇧		⇧		⇧		⇧		⇧		⇧		⇧		10	13										
M	125																																																		
N	200			⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩																									
P	315			⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧																									
Q	500			⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧																									
R	800	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧																									

⇩ = Use first-sampling plan below arrow. If sample size equals, or exceeds, lot or batch size, do 100% inspection.

⇧ = Use first-sampling plan above arrow.

Ac = Acceptance number.

Re = Rejection number.

† = If the acceptance number has been exceeded, but the rejection number has not been reached, accept the lot, but reinstate normal inspection.

Appendix VI

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2012/2013
COURSE : QUALITY CONTROL

PROGRAMME : 2 BPB
COURSE CODE : BPB 24303

Process Capability Cp Cpk

$$C_p = \frac{USL - LSL}{6\sigma_0}$$

$$C_{pk} = \frac{Min\{(USL - \overline{\overline{X}}) \text{ or } (\overline{\overline{X}} - LSL)}{3\sigma}$$

Trial Central Line and Control Limits

$$\overline{\overline{X}} = \frac{\sum_{i=1}^{g} \overline{X_i}}{g} \quad and \quad \overline{R} = \frac{\sum_{i=1}^{g} R_i}{g}$$

$$UCL_{\overline{X}} = \overline{\overline{X}} + A_2\overline{R} \qquad UCL_R = D_4\overline{R}$$

$$LCL_{\overline{X}} = \overline{\overline{X}} - A_2\overline{R} \qquad LCL_R = D_3\overline{R}$$

Revised Central Line and Control Limits

$$\overline{\overline{X}}_{new} = \frac{\sum \overline{X} - \overline{X_d}}{g - g_d} \quad and \quad \overline{R}_{new} = \frac{\sum R - R_d}{g - g_d}$$

Trial Central Line and the Control Limits

$$\overline{p} = \frac{\sum np}{\sum n}$$

$$UCL = \overline{p} + 3\sqrt{\frac{\overline{p}(1-\overline{p})}{n}}$$

$$LCL = \overline{p} - 3\sqrt{\frac{\overline{p}(1-\overline{p})}{n}}$$

Appendix VII

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2012/2013 PROGRAMME : 2 BPB
COURSE : QUALITY CONTROL COURSE CODE : BPB 24303

The Revised Central Line and Control Limits

$$\overline{p_{new}} = p_0 = \frac{\sum np - np_d}{\sum n - n_d}$$

$$UCL = p_0 + 3\sqrt{\frac{p_0(1-p_0}{n}}$$

$$LCL = p_0 - 3\sqrt{\frac{p_0(1-p_0)}{n}}$$

Trial Central Line and The Control Limits

$$\bar{\bar{s}} = \frac{\sum_{i=1}^{g} \bar{s}_i}{g} \qquad \bar{\bar{X}} = \frac{\sum_{i=1}^{g} \bar{X}_i}{g}$$

$$UCL_{\bar{X}} = \bar{\bar{X}} + A_3\bar{s} \qquad UCL_s = B_4\bar{s}$$

$$LCL_{\bar{X}} = \bar{\bar{X}} - A_3\bar{s} \qquad LCL_s = B_3\bar{s}$$

Revised Limits for s chart

$$\bar{X}_0 = \bar{\bar{X}}_{new} = \frac{\sum \bar{X} - \bar{X}_d}{g - g_d}$$

$$s_0 = \overline{s_{new}} = \frac{\sum s - s_d}{g - g_d} \qquad \sigma_0 = \frac{s_0}{c_4}$$

$$UCL_{\bar{X}} = \bar{X}_0 + A\sigma_0 \qquad UCL_s = B_6\sigma_0$$

$$LCL_{\bar{X}} = \bar{X}_0 - A\sigma_0 \qquad LCL_s = B_5\sigma_0$$

AOQ

$$AOQ = \frac{p_a p(N-n)}{N}$$

Deviation Chart

$$\frac{\bar{R}_{process}}{\bar{R}_{total}} \leq 1.3$$

Z and MW charts

$$Z = \frac{X - Target\ \bar{X}}{Target\ \bar{R}}$$

$$MW_{i+1} = Z_i - Z_{i+1}$$

Appendix VIII

FINAL EXAMINATION

SEMESTER / SESSION : SEM II / 2011/2012 PROGRAMME : 2 BPB
COURSE : QUALITY CONTROL COURSE CODE : BPB 24303

Mean time to failure

$$E(t) = \frac{1}{\lambda}$$

Variance of the time to failure

$$V(t) = \frac{1}{\lambda^2}$$

Reliability function

$$R(t) = e^{-} \lambda^{t}$$

Probability function failure before the mean life

$$1 - R(t)$$

Instantaneous Failure Rate

$$h(t) = \frac{r}{Q} = \frac{r}{\sum_{i=1}^{r} t_i + (n-r)T}$$

-END OF QUESTION-